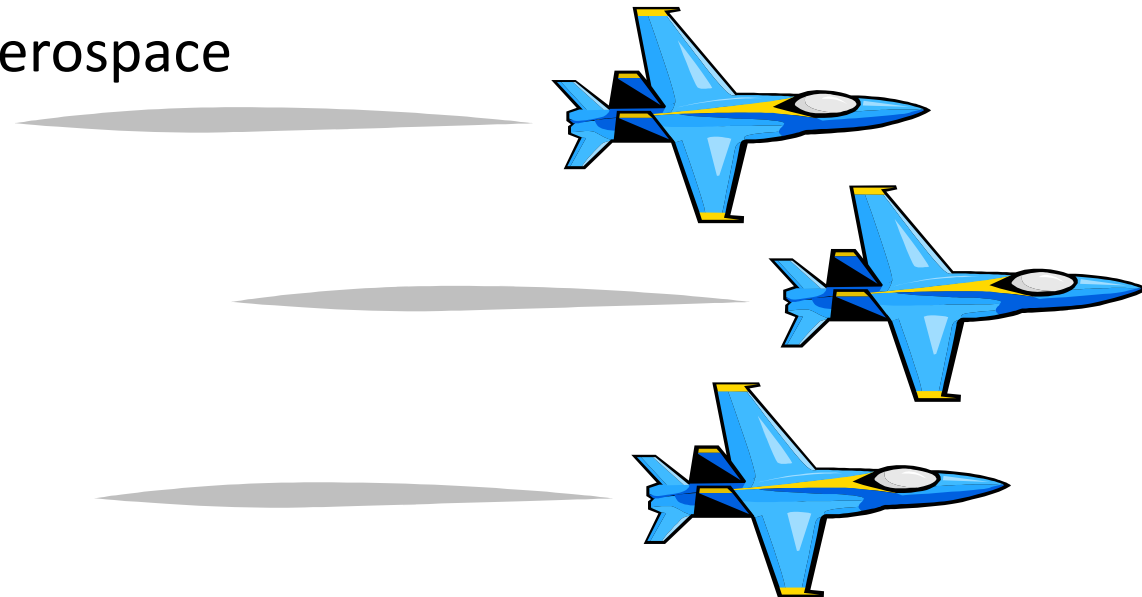


# Introduction to Aerospace

History of Flight

Introduction to Aerospace

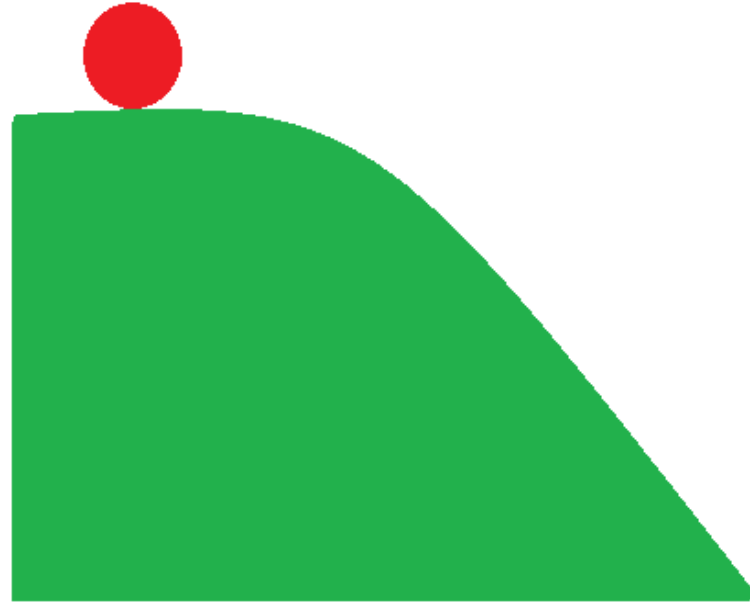


# Name as many types of Energy that you can:

- Mechanical
- Thermal (Heat)
- Electrical
- Chemical
- Electrochemical
- Electromagnetic (Light)
- Sound
- Nuclear

## Potential

- Energy that is stored



## Kinetic

- Energy in motion



# Heat

- Heat is Energy Transfer
  - Thermal Energy transferred from one substance to another
- Units of Heat
  - Joules (J)
  - Calories (cal)
    - Amount of heat needed to raise the temperature of one gram of water by one degree Celsius
    - $1 \text{ cal} = 1 \text{ g}/^{\circ}\text{C} = 4.19 \text{ J}$
    - Not the same as the calories in food
    - These are actually kilocalories and measure how much energy is stored in a certain amount of food.
  - BTU (British Thermal Unit)
    - Still used in US, Canada, and many non-English speaking countries that use the metric system, mostly for power, heating, and air conditioning
    - $1 \text{ BTU} = 1,005 \text{ J}$

# Types of Heat Transfer

- Convection
- Conduction
- Radiation

Check out the visual dictionary at:

<http://visual.merriam-webster.com/science/chemistry/matter/heat-transfer.php>

# States of Matter

- Solid
- Liquid
- Gas
- The amount of movement of atoms and molecules in these states increases as you move from Solid to Liquid to Gas
- As an Ice cube melts, it is converting between solid and liquid forms of water
- If we boiled the water, it would convert between liquid and gas
- An increase in heat transfer into the water, increases the activity of atoms and molecules, and can lead to a change in state.

# States of Matter

- Gas – How do atoms and molecules move in a gas?
- Solid – do atoms and molecules move in a solid?
  - Solids lack the Kinetic Energy that would make the molecules move in space
  - The molecules in a Solid vibrate
- When we say something is warmer, what are we referring to?

# What is Temperature?

- Temperature is not the same as Energy
  - Measures the concentration of Thermal Energy in a system at a point in time.
  - Temperature is a measure of the average Kinetic Energy of the molecules in a substance
  - This reflects the amount of motion of the atoms and molecules
- Units of Temperature
  - Degrees Celsius
  - Degrees Fahrenheit
    - $^{\circ}\text{F} = (x)^{\circ}\text{C} \times 9/5 + 32$
  - Degrees Kelvin
    - $\text{K} = (x)^{\circ}\text{C} + 273.15$
    - 0K, or absolute zero – this is the point where all molecules have zero kinetic energy – all motion stops

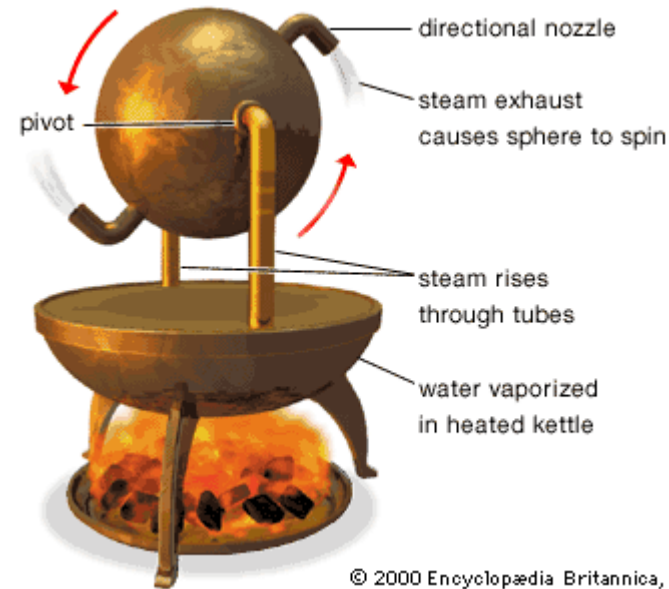


# Dreams of flight

- Greek legend of Icarus and Daedalus
- Kites
  - Used in China around 400 BCE
  - Religious ceremonies
  - Fun
  - Test weather conditions
- Birds as a model
  - Wings made with feathers, flapping their arms
  - Didn't work – why?

# Early approaches to flight

- Hero of Alexandria and the Aeolipile
  - Used steam to turn the sphere
  - Moves, but doesn't fly
  - Anticipates how a rocket works
- Leonardo da Vinci
  - 1480's
  - Ornithopter
  - Helicopter



# Joseph and Jacques Montgolfier

- French brothers who invented the first hot air balloons in 1783
- Balloons were silk, with a fire to put hot air in the balloon
- First passengers were a sheep, rooster, and a duck
- Height of 6000 feet, travelled more than a mile
- First manned flight – November 21, 1783



# Hydrogen Balloons

- Jacques Charles , also in 1783
- Filled the balloon with Hydrogen
  - Hydrogen – H – is lighter than air (mostly Nitrogen – N, and Oxygen – O)
- Balloon went higher and was in the air longer than the Montgolfier balloons
- The balloon material was still flammable, so a hot air balloon might catch on fire

# Hydrogen vs. Helium

- Hydrogen is very abundant on earth, and is the most abundant element in the universe
- Hydrogen is easily produced through chemical and biochemical processes
- Helium is the second most abundant element in the universe, but is relatively rare on earth
- Helium is extracted from the earth , usually with natural gas-
- Hydrogen is flammable, Helium is inert and not flammable

# Airships, Dirigibles, and Zeppelins

- Balloons were not really navigable
- Airships add propulsion and steering
- Henri Giffard – 1852, builds the first airship
- Adds a small steam engine, a propeller and went 17 miles at a max of 5 mph
- Practical airships come along in 1898 after the gasoline engine is invented
- Alberto Santos-Dumont (Brazilian) -1898, used a powered tricycle

# Airships, Dirigibles, and Zeppelins

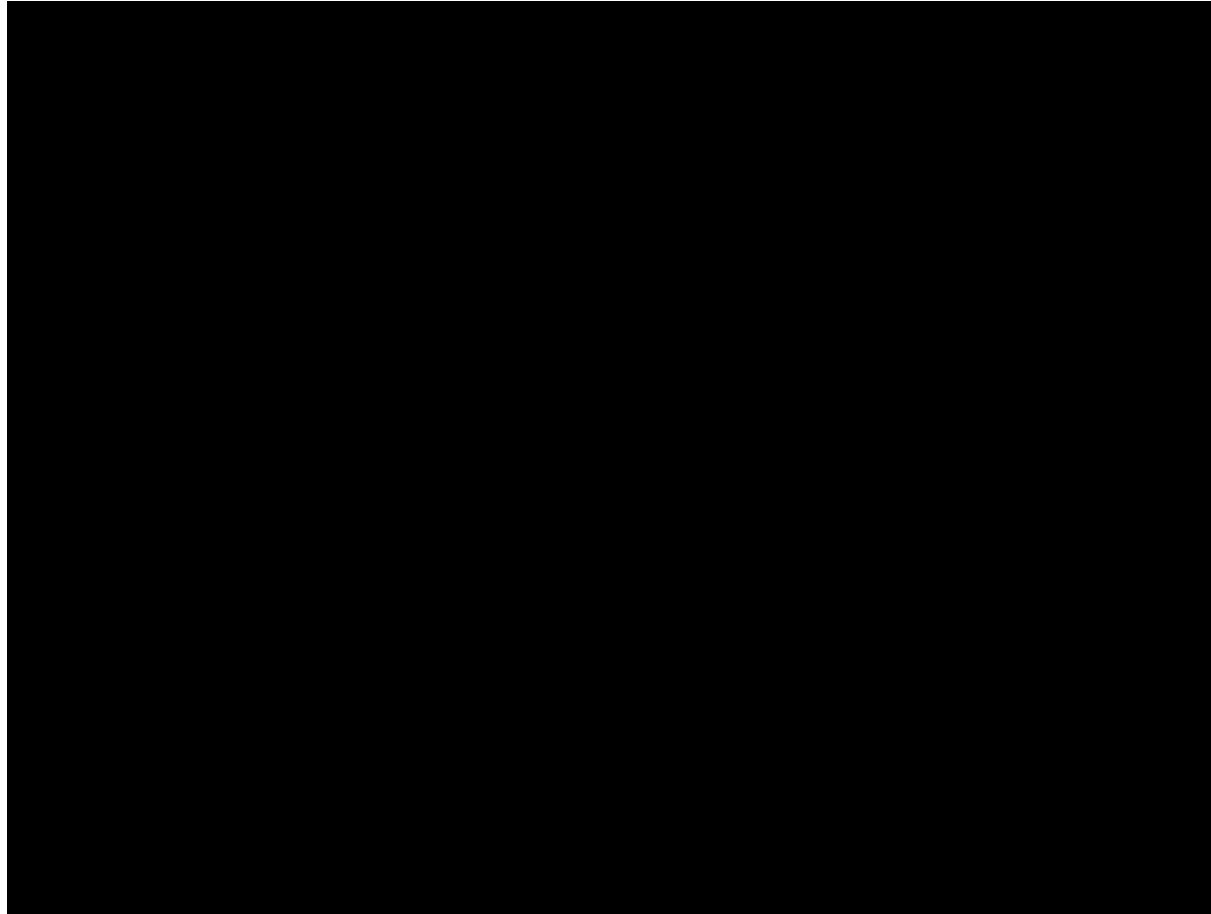
- Zeppelins were named after Count Ferdinand von Zeppelin who invented the internally-framed dirigible.
- Aluminum structure, cloth covering
- First in 1900
- Graf Zeppelin flew over 1,000,000 miles, from 1931-37
- Used Hydrogen
- Hindenburg flew from 1936-37

# Why did the Germans use Hydrogen?

- During World War I, balloons were used as observational tools during battle, so they were considered a military resource
- The US had the largest deposits of Helium in the Great Plains
- The US kept the Helium as a strategic resource and wouldn't sell it to the Germans
- When the Nazis took over Germany in 1933, this was even more of an issue given their interest in building up the German military



# Hindenburg disaster



# Other types of airships

- Non-rigid airship or Blimp
- Semi-rigid airship

# Gliders

- George Cayley (English) – between 1799 and the 1850's, he made many operational versions of gliders

# 19<sup>th</sup> Century Gliders and Airplanes

- Jean-Marie Le Bris – 1868 – France
  - First to fly higher than the point of departure
- Felix du Temple de la Croix – 1874 - France
  - First take off of a manned and powered aircraft – used a ramp
- Victor Tatin aeroplane – 1879 - France
  - First airplane to lift itself under its own power – unmanned, used compressed air
- Otto Lilienthal – Germany – The Glider King
  - Worked with his brother Gustav to design many different gliders
  - Flew gliders from 1891-1896
  - Died from wounds sustained in a crash

# Wright Brothers

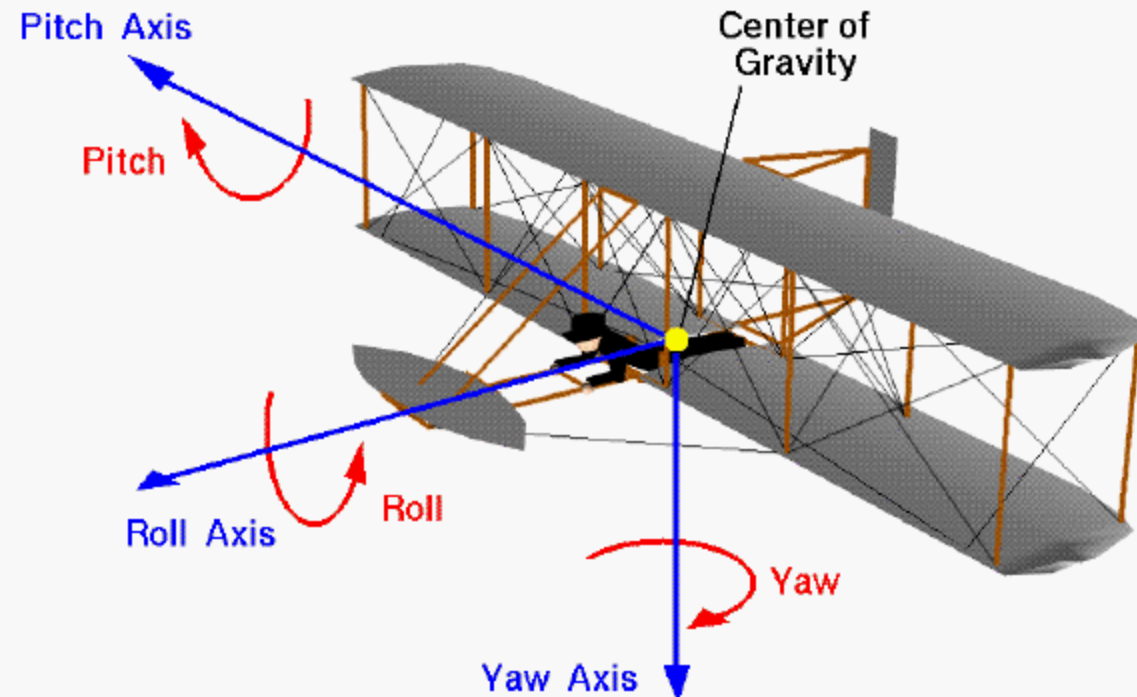
- Built three major gliders
- 1900 – Flew at Kitty Hawk
  - Flew like a kite
  - Tested wing warping to control glider
- 1901
  - Larger, flew 50-100 times
- 1902
  - Achieved 3-axis control
    - Roll
    - Pitch
    - Yaw

# Roll, Pitch and Yaw



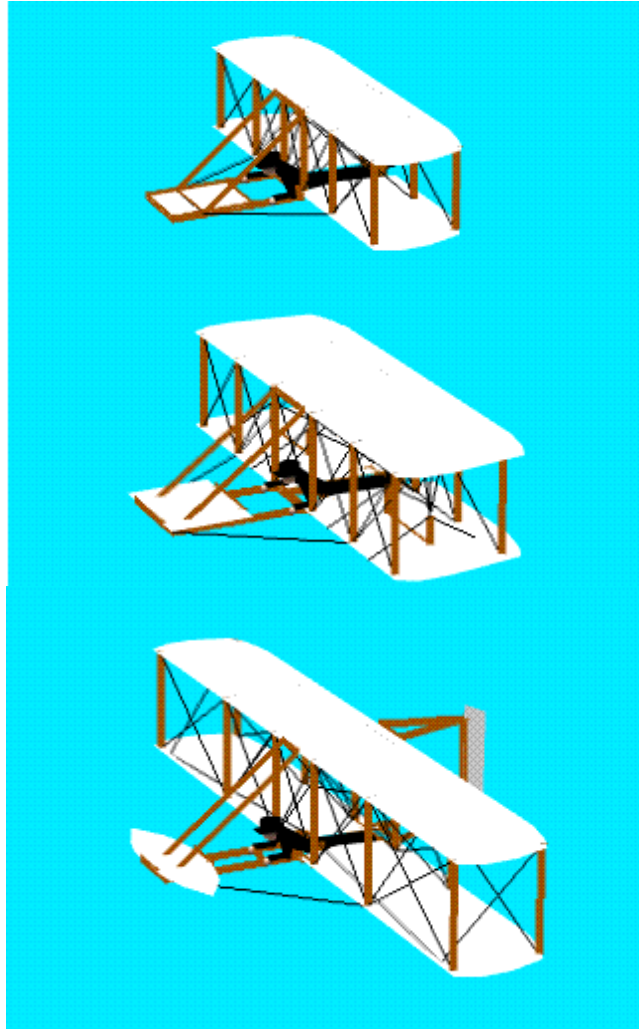
## **Aircraft Control** *Wright 1902 Glider*

Glenn  
Research  
Center



# Orville and Wilbur Wright - Gliders

- Each Gliders was larger, flew more times, and for greater distances
- Improvements each time in terms of structure and control
- Built their ideas on those of Cayley, Langley and Lilienthal



**1900**

17 ft span, 165 sq ft area  
50 lbs – empty weight

Flown mostly as a kite  
< 12 glider flights  
~ 300 ft max distance

**1901**

22 ft span, 290 sq ft area  
100 lbs – empty weight

Flown mostly as a glider  
> 50 glider flights  
~ 400 ft max distance

**1902**

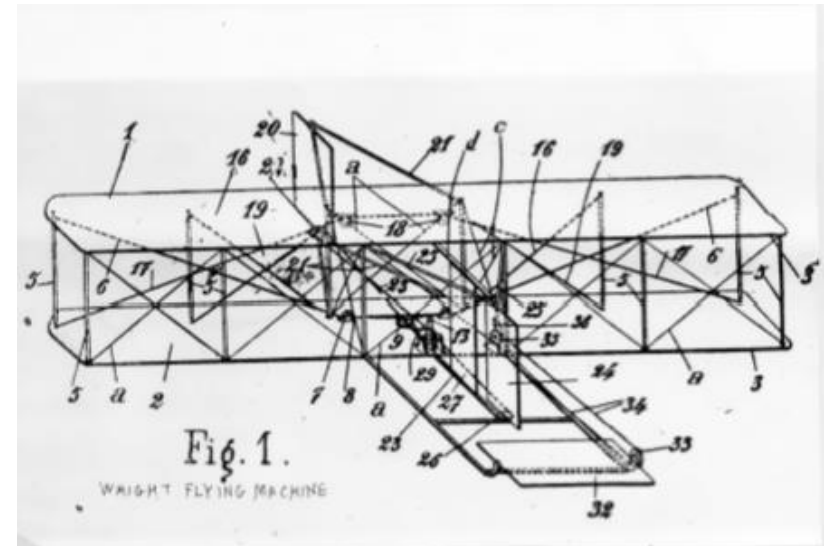
32 ft span, 305 sq ft area  
115 lbs – empty weight

First aircraft with control  
in all three directions

> 1000 flights  
~ 650 ft max distance  
~ 25 sec. max duration

# George Cayley

- Adjustable tail mechanism
- Dihedral wings (set lower in the center and higher at the ends)
  - Created more lift
- “On Aerial Navigation” In this, he is the first to state that lift, propulsion, and control were required for successful flight.
- Designed airships
- 1848 – Monoplane Glider Design
- 1849 – Built a gliding machine, flew for a short time , carrying a 10 year old boy





# Samuel Langley

- Worked on models first
- Aerodromes
- Added power plant to a glider
- 1903 - His aerodrome crashed immediately into the Potomac River

